

CLAIMS

- 1           1.       An engine startup fuel control system for use with an internal  
2       combustion engine of the type having a plurality of combustion chambers, an  
3       intake air passage fluidly connected each combustion chamber and a source of  
4       fuel, said fuel control system comprising:
  - 5           a multipoint fuel injector associated with each combustion chamber,  
6       each multipoint fuel injector having an inlet connected to said fuel source and  
7       an outlet fluidly connected to said intake air passageway adjacent its associated  
8       combustion chamber,  
9           a cold start fuel injector having an inlet connected to said fuel source  
10      and an outlet fluidly connected through a cold start passageway with each  
11      combustion chamber,  
12      processing means for selectively activating each of said multipoint fuel  
13      injectors and said cold start fuel injector,  
14      said processing means having means for determining the air/fuel  
15      mixture introduced by said cold start fuel injector into at least one combustion  
16      chamber during engine startup,  
17      said processing means having means responsive to said determining  
18      means for selectively activating each said multipoint fuel injector to achieve a  
19      predetermined air/fuel mixture in each combustion chamber during engine  
20      startup.

1           2.     The invention as defined in claim 1 wherein said determining  
2     means determines the air/fuel mixture introduced by said cold start fuel injector  
3     into each combustion chamber during startup.

1           3.     The invention as defined in claim 1 wherein the engine includes  
2     a main drive shaft and comprising:  
3                 a position sensor which provides an output signal representative of the  
4     angular position of the main shaft, said output signal from said position sensor  
5     being connected as an input signal to said processing means,  
6                 said processing means comprises means responsive to said output signal  
7     from said position sensor for determining the rotary speed of the main shaft,  
8                 wherein said processing means begins activation of said multipoint fuel  
9     injectors and said cold start fuel injector at a predetermined rotary speed of the  
10    main shaft during engine startup.

1           4.     The invention as defined in claim 1 and comprising a spark  
2     ignition system having a spark igniter associated with each combustion  
3     chamber, and means for retarding activation of the spark igniter for at least one  
4     combustion chamber during engine startup.

1           5.     The invention as defined in claim 4 wherein said retarding  
2     means comprises means for retarding an ignition timing of at least one of the

3 spark igniters during engine startup so that the ignition timing of said at least  
4 one spark igniter is different than the other spark igniters.

1 6. The invention as defined in claim 1 wherein said processing  
2 means activates said cold start fuel injector for at least two spaced pulses per  
3 combustion charge per cylinder.

1 7. The invention as defined in claim 1 wherein said processing  
2 means activates said cold start fuel injector for at least three spaced pulses per  
3 combustion charge per cylinder.

1 8. An engine startup fuel control system for use with an internal  
2 combustion engine of the type having a plurality of combustion chambers, an  
3 intake air passage fluidly connected each combustion chamber, a cold start fuel  
4 passageway having an inlet and an outlet, the cold start fuel passageway outlet  
5 being fluidly connected to the combustion chambers and a source of fuel, said  
6 fuel control system comprising:

7 a multipoint fuel injector associated with each combustion chamber,  
8 each multipoint fuel injector having an inlet connected to the fuel source and an  
9 outlet fluidly connected to said intake air passageway adjacent its associated  
10 combustion chamber, each said multipoint fuel injector, upon activation,  
11 injecting fuel into its associated combustion chamber,

12           a cold start fuel injector having an inlet connected to said fuel source  
13           and an outlet fluidly connected to the inlet of the cold start fuel passageway,  
14           said cold start fuel injector, upon activation, introducing a fuel charge into the  
15           inlet of the cold start fuel passageway,

16           processing means for producing a predetermined combustible charge in  
17           each combustion chamber during engine startup by selectively activating said  
18           multipoint fuel injectors during engine startup to provide fuel to each  
19           combustion chamber sufficient to compensate for any transport delay of the  
20           fuel charge from the cold start fuel injector through the cold start fuel  
21           passageway.

1           9.     The invention as defined in claim 8 wherein the engine includes  
2           a main shaft and wherein said processing means initiates activation of said cold  
3           start fuel injector and said multipoint fuel injectors at a predetermined  
4           rotational speed of said main shaft.

1           10.    The invention as defined in claim 8 and comprising a spark  
2           ignition system having a spark igniter associated with each combustion  
3           chamber, and means for retarding activation of the spark igniter for at least one  
4           combustion chamber during engine startup.

1           11.    The invention as defined in claim 10 wherein said retarding  
2           means comprises means for retarding an ignition timing of at least one of the

3 spark igniters during engine startup so that the ignition timing of said at least  
4 one spark igniter is different than the other spark igniters.

1 12. The invention as defined in claim 8 wherein said processing  
2 means activates said cold start fuel injector for at least two spaced pulses per  
3 combustion charge per cylinder.

1 13. The invention as defined in claim 8 wherein said processing  
2 means activates said cold start fuel injector for at least three spaced pulses per  
3 combustion charge per cylinder.

1 14. A method for managing fuel delivery in an internal combustion  
2 engine having multiple combustion chambers during engine startup, said  
3 engine having a main shaft and a multipoint fuel injection associated with each  
4 combustion chamber and a cold start fuel injector which, upon activation,  
5 provides a fuel charge to at least a plurality of combustion chambers through a  
6 cold start fuel passageway, said method comprising the steps of:  
7 determining the rotational speed and angular position of the main shaft,  
8 activating the cold start fuel injector when the main shaft reaches a  
9 predetermined rotational speed,  
10 calculating the air/fuel charge provided to each combustion chamber by  
11 the cold start fuel injector as a function of the angular position of the main shaft  
12 and time of activation of the cold start fuel injector, and

13           selectively activating at least one multipoint fuel injectors in response  
14   to said calculating step to achieve a predetermined combined fuel charge from  
15   said cold start fuel injector and said multipoint fuel injectors in each  
16   combustion chamber.

1           15.    The invention as defined in claim 14 and comprising the step of  
2   retarding combustion in at least one combustion chamber during engine startup.

1           16.    The invention as defined in claim 15 wherein said retarding step  
2   further comprises the step of retarding combustion in at least one combustion  
3   chamber in an amount different than the other combustion chambers.

1           17.    The invention as defined in claim 14 wherein said activating  
2   step comprises the step of activating the cold start fuel injector in a plurality of  
3   pulses for the fuel charge provided to each combustion chamber by the cold  
4   start fuel injector.

1           18.    The method of claim 14 wherein said activating step further  
2   comprises the step of selectively activating each said multipoint fuel injectors  
3   in response to said calculating step to achieve a predetermined combined fuel  
4   charge from said cold start fuel injector and said multipoint fuel injectors in  
5   each combustion chamber.

1           19.     An engine startup fuel control system for use with an internal  
2     combustion engine of the type having a plurality of combustion chambers, an  
3     intake air passage fluidly connected each combustion chamber, a spark igniter  
4     associated with each combustion chamber and a source of fuel, said fuel  
5     control system comprising:  
6           means for providing fuel to the combustion chambers during engine  
7     startup,  
8           means for selectively activating the spark igniters associated with  
9     combustion chambers to initiate fuel combustion in the combustion chambers,  
10    means for selectively retarding activation of at least one of the spark igniters  
11    during engine startup in an amount different than the other spark igniters.

1           20.     The invention as defined in claim 19 wherein the internal  
2     combustion engine includes two banks of cylinders and wherein said selective  
3     retarding means selectively retards two aligned cylinders in opposite banks of  
4     the engine.

1           21.     An engine startup fuel control system for use with an internal  
2     combustion engine of the type having a plurality of combustion chambers, an  
3     intake air passage fluidly connected each combustion chamber, a cold start fuel  
4     passageway having an inlet and an outlet, the cold start fuel passageway outlet  
5     being fluidly connected to the combustion chambers and a source of fuel, said  
6     fuel control system comprising:

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7           a multipoint fuel injector associated with each combustion chamber,  
8           a cold start fuel injector having an inlet connected to said fuel source  
9           and an outlet fluidly connected to the inlet of the cold start fuel passageway,  
10          said cold start fuel injector, upon activation, introducing a fuel charge into the  
11          inlet of the cold start fuel passageway,  
12          means for activating said cold start fuel injector in a plurality of pulses  
13          to produce the fuel charge for each combustion cycle of each combustion  
14          chamber.